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RUTHENIUM DETECTION BY XRF IN METAMORPHIC ROCKS

RODRÍGUEZ P., OMAR[1], JORGE E, LOPEZ C[2]., MIKEL F. HURTADO M[3]., PÉREZ M. ANGIE CH[4], MEJIA M., DANNA B[5] & MEJÍA M., JORGE I[6]

[1,2,3] *Universidad Central. Ingeniería Electrónica*

[4,5] *Fundación Universidad Autónoma de Colombia*

[6] *Instituto de Hidrología, Meteorología y Adecuación de Tierras HIMAT*

ABSTRACT

The following report shows the experimental results of detecting Ru (ruthenium) element, in metamorphic rocks, found on different geographic areas of Colombian, performing X-ray fluorescence spectroscopy (XRF). After field work, developed by the group and in order to classify the different rock samples, obtained at the outputs from different Colombian areas (white beach in Santa Marta, Cartagena, Sierra Nevada de Santa Marta, Chicamocha´s Canyon Santander and near Villa de Leyva Boyaca), in a particular group of samples (Chicamocha´s Canyon Santander), was detected Ru, by XRF a rare element in nature, but even more uncommon in this area.

KEYWORDS: Amphibolite, Feldspar, Gneiss & Igneous Rocks

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Original Article

INTRODUCTION

Platinum, palladium, rhodium, osmium and ruthenium are used in oil refining, automotive industry, due mainly to their corrosion and acid resistance. These metals are scarcy in the crust, also in Colombian areas. For more than 2 years the formed work group conformed by environmental engineering students (Fundación Universidad Autonoma) and professors from Electronic Department (Universidad Central), have invested their efforts in classify and characterize crystals and rocks around Colombia, especially in semi-desert zones like Villa de Leyva, la Guajira and Chicamocha´s canyon. One of the main objectives in this research work is related to find unclassified minerals, with Ru around Colombian areas, useful information to be use for Ingeominas, were performed XRF analysis and already well known purity precious stones analysis, used for local jewelers. A measurement element protocol was established, in order to identify clearly the samples collected.

Theoretical Model

When a sample is radiated with X-rays, it may happen that dispersed radiation has not energy loss (Rayleigh), or has loss (Compton), or if the energy is high enough a vacancy in certain atomic level, could be created (photoelectric effect). In the last case, the excited atomic level decays, due to fill out the previous vacancy for an electron that comes from a lower energy level, releasing certain energy in two different forms [1]:

- As X-ray photon, where the probability is represented, by fluorescence production.
- As a transferring process of a certain electron that, coming from a lower energy level, which is ejected from the atom and finally causing two vacancies (Auger effect).

The XRF spectroscopy is based in the first phenomena, identifying and characterizing fluorescence lines. The intensity fluorescence radiation is defined as a function (I), that depends of variables like; incident beam wavelength λ, mass absorption coefficient (ρ/μ), and other variables, that in this case are not enough relevant, but at the same time is really important the energy pick function or spectral line.

$$I(\lambda) = I_o f(\lambda, \rho, \mu, \dots) \quad (1)$$

Where, I_o – is the initial monochromatic beam intensity?

Is well known that, the theoretical calculation of the absorbed radiation intensity by the sample could fit with Lamber-Beer law, using the case of composed materials, this function is calculated as:

$$I(\lambda) = I_o exp\left[-\left(\mu_m \lambda \frac{\rho x}{cos(\theta_i)}\right)\right] \quad (2)$$

Where: μ_m- sample´s mass coefficient; ρ - Samples density; θ_i – incident beam angle, respect to the simple.

Outside Work

The first sample´s group (50), collected randomly on Playa Blanca Santa Marta, showed an ***Epidote***type crystal using XRF analysis (see Figure. 1).

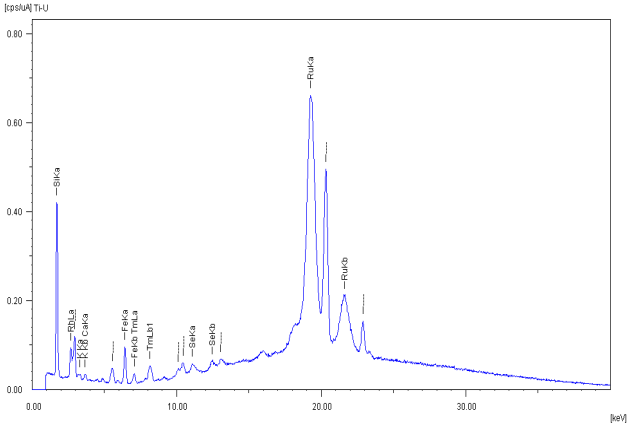

Figure 1: Epidote Sample XRF Spectrum. Sample from Playa Blanca Santa Marta Area

The sample analyzed in (figure. 1), corresponds a quartz like structure, which presents a slight mate shine on its surface, due to its highly silicon concentration 54.567%, it may have been embedded in a little rock simple, together with the epidote mineral (greenish mineral), but at the same time presents traces of Ru.

Other samples collected in the same place, but now Bornite type, do not show traces or significant Ru concentration, but a significant Fe concentration of 15,26 % de Fe, as showed in figure2.

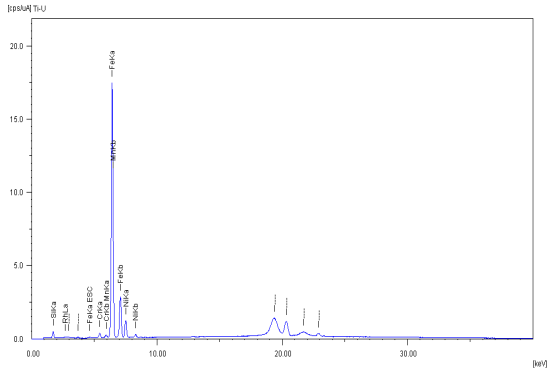

Figure 2: Bornite Sample XRF Spectrum. Sample from Playa Blanca Santa Marta Area

In other region of Colombian, in Chicamocha´s canyon area (Santander), were analyzed samples mica schist like, with 42,86% of Si concentration, being evident the presence of mica (muscovite type) and biotite type structures. The XRF spectroscopy analysis is showed in figure3.

The second set of samples (150), collected in other regions of Colombia mainly in Cauca, Amazonas and Cundinamarca were analyzed also by XRF. One particular sample was classified, as igneous volcanic rock, which presents the next XRF signals (see Figure. 4.)

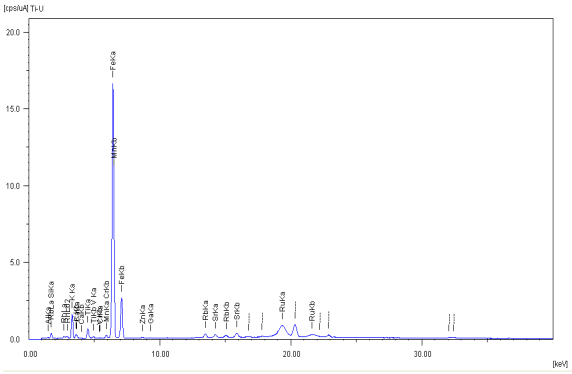

Figure 3: Mica Schist Sample XRF Spectrum. Sample from Chicamocha´s Canyon (Santander) Area

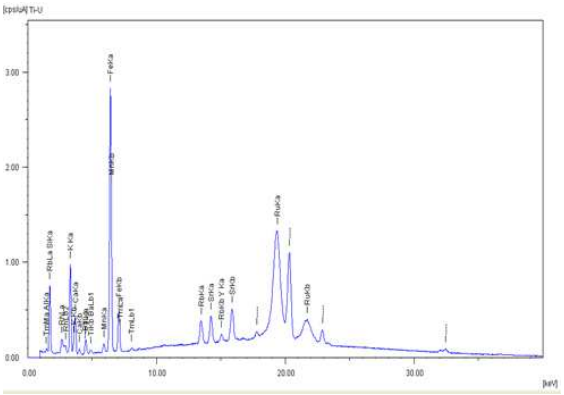

Figure 4: Igneous Volcanic Rock Sample XRF Spectrum Sample from Sopo-Cundinamarca

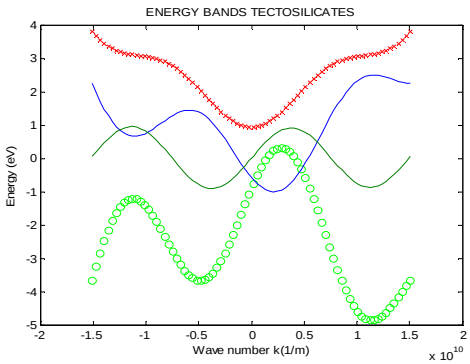

Figure 5: Simulated Behavior of Energy Bands of Tectosilicate Materials Dislocations. The Fermi Level (Green) Shows the Tendency of Energy Deformation Close to the Structural Dislocations in Presence of Ru

The Ru concentration in the previous samples, allows assuming the possible formation environment, when the results are compared with XRD Ru content patterns. The samples quartz type (Playa Blanca, Santa Marta area), is a special case, taking in to account the literature showed that, Ru content is characteristic from (1000-2000 ma.s.l), as the case of Ural Mountains, for this reason quartz samples were carried out, through of a transport process and erosion by means of a rock coming from a near place.

Last but not the least, one of the suggested problem, developed during this research report is related with energy bands behavior of studied materials (mostly tectosilicates), and even more in presence of Ru. The above mentioned behavior is showed in figure5.

Electronic Measurement Model

Taking in to account the information above, in the MAXWELL group laboratories, were designed an electronic device, that determines directly the apparent density of a studied sample, this measurement does not depend of sample shape, getting the mass coefficient sample directly.

The electronic device (capacitive system), takes a sinusoidal signal in the range of (35-130) KHz, with pick voltage of 5V, in a voltage DC data generated, by dipoles distribution in the local network of the rock, that realize different structures of the compound in the loss factor of the energy, due to a heat dissipation and X-ray absorption.

CONCLUSIONS

One of the most important contributions of this research work is the relation between the energy behaviors of tectosilicate materials (analyzed by XRF), in the presence of Ru and their structural dislocations. In terms of atomic transitions (Tectosilicate materials) is not direct and the transmission energy process is due, mainly by network vibrations and not for collision phenomena, due to beam energy incident.

As mentioned above, the Ru presence is evident mostly in Chicamocha´s canyon (Santander), where the physical process of erosion and transport phenomena, allowed a certain grade of material detach with block sizes around (256 mm), guijón (64-256 mm), reaching the precise place; in a similar proportion were evident and the presence of Ru in a volcanic igneous rock, which confirms that, Ru comes from mountain's chains, mainly in ultramafic rocks, it means, in depths, where the change of metamorphic-igneous rock happens due to crystallization and fusion processes; however, it is necessary to do a new research project, that allowed us to stablish a possible source and generation of this rare and fascinating

element.

This problem is open to be resolved, using more different rocks and be analyzed by XRF, with the main objective to determine sources or streaks with Ru content, in order to put this information on data bases of governmental institutes, mining companies or geographical classification entities, and be used to explore with highly control and efficiently, without causing environmental impacts.

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